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by Beiling Yan

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Telephone: (613) 951-1804

Purchasing Power Parity: A Canada/U.S. Exploration

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Beiling Yan

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Micro Economic Analysis Division
24th Floor, R.H. Coats Building
Statistics Canada
Ottawa, K1A 0T6
(613) 951-1234
E-mail: yanbeil@statcan.ca
Fax: (613) 951-5403

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Abstract

The paper examines the possible explanations for deviations from purchasing power parity (PPP) between Canada and the United States in the 1980s and 1990s. The Balassa-Samuelson (B-S) model is used as the basis for the empirical exercise. In the B-S model, where PPP is assumed to hold for tradable goods, the real exchange rate (corrected by the exchange rate between two countries) reflects the bilateral differences in the relative productivity of the tradable and nontradable sectors. We investigate both the productivity effect and the underlying PPP assumption for tradable goods.

Using a Canada/U.S. micro data set on four benchmark years (1985, 1990, 1993 and 1996), we apply univariate and nonparametric analysis and obtain several results. First, purchasing power parity is rejected for both tradables and nontradables during the time period examined. Within tradables, however, PPP is rejected for differentiated but not for homogeneous commodities. Second, price differences for tradables are decreasing in the 1990s, a period of increasing free trade between the two countries. Third, we find little support for a simple version of the Balassa-Samuelson productivity explanation of the diverging average prices (adjusted by exchange rate) between the two countries in the 1990s. We do find a relationship between these variables but it involves a lag structure that requires further study.

Keywords: purchasing power parity, Canada and United States

JEL Code: F10, F31

Executive Summary

The concept of purchasing power parity (PPP) is commonly used, either in many theoretical models in international economics, or in its practical applications by statistical agencies. Behind PPP is the law of one price (LOP), which holds that, in a perfectly competitive world economy a commodity should sell at the same price everywhere. The mechanism of enforcing the law of one price is commodity arbitrage. If the law of one price applies to each commodity as a result of arbitrage, and if countries have the same expenditure patterns (thus the same weight assigned to each commodity), then for a common basket of goods the aggregate price will also obey the law of one price. In other words, national price levels for a common basket of goods will be equal when converted to a common currency.

However, the aggregate prices between Canada and the United States have been increasingly diverging since the 1990s. Does this mean that the law of one price does not hold? Or are there any fundamental differences between the U.S. and Canadian economies that drive the differential movements in national prices? The paper investigates these two questions.

Based on our univariate and nonparametric analysis of the newly available micro data-set, which contains Canada/U.S. bilateral relative prices on more than 168 matched goods and services for four benchmark years (1985, 1990, 1993 and 1996), the paper finds:

- Purchasing power parity is rejected for both tradables and nontradables. Within tradables, however, PPP could not be rejected for homogeneous goods, though it is rejected for differentiated commodities. The results highlight that care must be taken to distinguish between different commodity groups when evaluating the PPP hypothesis.

- Price differentials for tradables are decreasing in the 1990s. This coincides with a period of increasing free trade between Canada and the United States. However, there was no significant trend in the price differentials for nontradables.

- We find little support for the Balassa-Samuelson productivity explanation of diverging average prices (adjusted by the exchange rate) between the two countries.

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Introduction

The idea behind purchasing power parity (PPP) is the law of one price (LOP), which holds that, in a perfectly competitive world economy and in the absence of frictions such as transport costs and tariff and non-tariff trade barriers, a commodity should sell at the same price everywhere. The mechanism of enforcing the law of one price is commodity arbitrage.

If the law of one price applies to each commodity through arbitrage, and if countries have the same expenditure patterns (thus the same weight assigned to each commodity), then for a common basket of goods the aggregate price will also obey the law of one price. In other words, national price levels for a common basket of goods are equal when converted to a common currency. Thus, if we define the real exchange rate (RER) as the relative price of a common basket of goods measured in the same currency, the PPP hypothesis predicts that the real exchange rate should be equal to one, or at least tend towards one in the long run. In the literature, this is referred to as absolute PPP.[1] To recognize frictions and allow some permanent wedge between countries' price levels, a weaker statement is that the real exchange rate shall be equal to or tend towards a constant in the long run.[2]

Figure 1 shows the nominal exchange rate, the relative price in own currency (not corrected by the exchange rate) and the relative price in the same currency (corrected by the exchange rate) between Canada and the United States in the 80s and 90s. The relative price corrected by the exchange rate is also referred to, herein, as the real exchange rate (RER). We observe that it fluctuated around one in the 80s, but has been increasingly diverging away from one since the 90s. Does this mean that the law of one price does not hold? Or are there any fundamental differences between the US and Canadian economies that drive the differential movements in the national price levels? The paper investigates these two questions.

The analytical framework used in the study is the Balassa-Samuelson hypothesis (Balassa 1964, Samuelson 1964). Balassa and Samuelson (B-S) identify the importance of nontradable goods and demonstrate how the deviation from PPP is systematically linked to productivity differentials between the tradable and the nontradable sectors. In the B-S model, the national price level depends on the price of tradable goods and on the relative price of nontradable to tradable goods. The price of tradable goods is assumed to be equal across countries through the law of one price. The relative price of nontradable goods is demonstrated to be positively related to the relative productivity of tradable and nontradable sectors. The intuition behind the Balassa-Samuelson productivity hypothesis is that productivity improvement in the tradable sector pushes wages in that sector upward, given that the price of these tradable goods is determined by the world market. This, in turn, puts upward pressure on wages in the nontradable sector. However, since productivity improvements in that sector are less than in the tradable sector, the price of non-tradable goods must increase to compensate for the increase in wages. In this way, slower

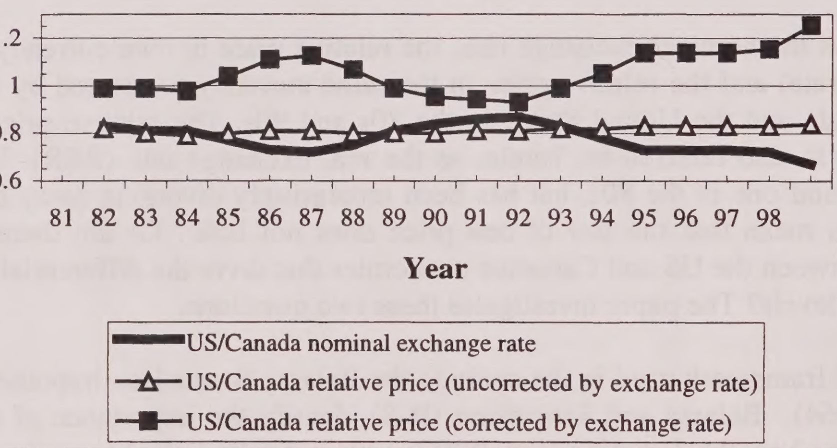
[1] *Absolute* PPP: $P_t^A/(E_t P_t^B) = 1$ where t is time, P^A is country A's price level in its own currency, P^B is country B's price level in its own currency, and E is the nominal exchange rate (the ratio of country A's currency over country B's currency).

[2] *Relative* PPP: $P_t^A/(E_t P_t^B) = \beta$, where β is not necessarily equal to one, as it is in the absolute version. That is the real exchange rate is constant, but need not be one.

productivity growth in the nontradable sector increases the relative price of the nontradable goods, which, in turn, increases the aggregate price level. If two countries differ in the relative productivity of nontradable to tradable sectors, so will their national price level. The B-S explanation of PPP deviation relies on two main hypotheses. First, it assumes PPP holds for tradable goods. Second, the relative price of nontradable to tradable goods reflects the differential productivity between tradable and non-tradable sectors. We investigate both hypotheses: the PPP for tradable goods and the differential productivity effect.

The paper is organized as follows. Section 2 outlines the Balassa-Samuelson analytical framework. Section 3 investigates the law of one price and tests the PPP hypothesis. Section 4 explores the productivity effect and section 5 offers conclusions.

Figure 1. Price Comparison Canada and the United States



Data source: Kemp (1999), Statistics Canada Catalogue no. 13-001-XPB.

2. *Analytical Framework*

In this section, we briefly outline our analytical framework—the Balassa—Samuelson model.[3] Suppose a country's overall price level (P) is a geometric mean of tradable (P_T) and nontradable (P_N) commodity prices. Let α be the expenditure share on nontradable goods, then

$$P = P_T^{(1-\alpha)} P_N^{\alpha} = P_T [P_N / P_T]^{\alpha} \qquad (2.1)$$

Further, define the real exchange rate, Q, as the relative price measured in the same currency. That is,

$$Q = P^{us} / (P^{ca} E) \qquad (2.2)$$

where P^{us} is the U.S national price level in its own currency, P^{ca} is the Canadian national price level in its own currency, and E is the nominal exchange rate (the ratio of U.S. currency over Canadian currency). The real exchange rate measures U.S./Canada price differentials, or in other words, measures the extent of the deviation from PPP. If absolute PPP holds, then the real exchange rate should be equal to unity.

Assume expenditure shares are the same in the United States and Canada, i.e. $\alpha^{us} = \alpha^{ca}$. Taking logs of equation (2.2), we have

$$q = \log(Q) = q_T + \alpha[\log(P_N / P_T)^{us} - \log(P_N/P_T)^{ca}] \quad \text{and}$$
$$q_T = (\log P_T^{us} - \log P_T^{ca} - \log E) \qquad (2.3)$$

or in growth form

$$\hat{q} = \hat{q}_T + \alpha[\widehat{(P_N / P_T)}^{us} - \widehat{(P_N / P_T)}^{ca}] \qquad (2.3)'$$

where ^ is percentage change, and q_T is the real exchange rate for tradable goods. Equation (2.3) and (2.3)' indicate that the real exchange rate depends on the real exchange rate for the tradable goods and on the differences in the relative price of nontradable to tradable goods between the two countries. Consider equation (2.3). If PPP holds for tradable goods and if the relative price of nontradable goods is the same in the United States and Canada, then the logged real exchange rate equals zero and there is no departure from PPP at the aggregate level.

PPP for tradable goods hypothesis

In the B-S model, a small open economy is assumed. In such an economy, prices for tradable goods are determined by the international market. Accordingly, PPP is assumed to hold for tradable goods. That is, the real exchange rate (in logs) for tradable goods equals zero ($q_T=0$). This is the first hypothesis that we will test in section 3.

[3] The recent version is provided in Rogoff (1992) and Obstfeld (1993).

Differential productivity hypothesis

Balassa-Samuelson further demonstrates that the relative price of nontradable to tradable goods reflects productivity differentials between the tradable and nontradable sectors. The basic derivation is as follows. Assume each sector is characterized by a constant return to scale production function with two inputs – capital and labour.

$$Y_T = A_T F(K_T, L_T) \qquad (2.4)$$
$$Y_N = A_N G(K_N, L_N) \qquad (2.5)$$

Or equivalently

$$y_T = A_T f(k_T) \quad \text{and} \quad k_T = K_T/L_T \qquad (2.4)'$$
$$y_N = A_N g(k_N) \quad \text{and} \quad k_N = K_N/L_N \qquad (2.5)'$$

where Y_i, K_i, L_i, A_i, y_i, k_i stand for output, capital labour, Hicks-neutral technology, per-capita output and capital-labour intensity for sector i respectively. Subscript i denotes tradable (T) and nontradable (N) sectors.

Assume further that capital is mobile, both internationally and between sectors in the economy, and that labour is mobile between sectors, but not internationally. This implies that the real interest rate (r) and the real wage (w), measured in tradable goods, are the same across sectors, with the interest rate determined by the international market. Perfect competition and profit maximization then yield the following relation:

$$A_T f'(k_T) = r \qquad (2.6)$$
$$(P_N/P_T)\, A_N\, g'(k_T) = r \qquad (2.7)$$
$$A_T [f(k_T) - f'(k_T)k_T] = w \qquad (2.8)$$
$$(P_N/P_T)\, A_N [g(k_N) - g'(k_N)k_N] = w \qquad (2.9)$$
$$A_T f(k_T) = r\, k_T + w \qquad (2.10)$$
$$A_N g(k_N) = r\, k_N + w \qquad (2.11)$$

Equations (2.6)-(2.9) are the first-order conditions for profit maximization, i.e. the marginal product of a factor equals its marginal cost. Equations (2.10)-(2.11) are the zero profit conditions under perfect competition assumption. Total differentiating equations (2.5) to (2.10), we obtain equation (2.12) with ^ denoting percentage changes and θ_{LN} and θ_{LT} being the labour cost shares in the nontradable and tradable sectors respectively.

$$\widehat{(P_N / P_T)} = (\theta_{LN} / \theta_{LT})\, \hat{A}_T - \hat{A}_N \qquad (2.12)'$$

Integrating equation (2.12)', we have equation (2.12) with c being the constant.

$$\log(P_N / P_T) = c + (\theta_{LN} / \theta_{LT}) \log A_T - \log A_N \qquad (2.12)$$

Equations (2.12) and (2.12)' demonstrate that there is a positive relationship between the relative price of nontradable to tradable goods and the relative productivity of tradable to nontradable goods sector. Take the growth equation (2.12) as an example. If $\theta_{LN} = \theta_{LT}$ (i.e. both sectors have the same labour-intensity), then a faster productivity growth in the tradable sector will result in an increase in the relative price of nontradable goods. If $\theta_{LN} > \theta_{LT}$ (i.e. the nontradable goods sector is more labour intensive than the tradable goods sector), then even an equal growth in productivity in the two sectors will lead to an increase in the relative price of nontradable goods. The increase in the relative price, in turn, leads to a rise in the aggregate price level through equation (2.1).

The intuition behind the Balassa-Samuelson productivity hypothesis is that productivity improvement in the tradable sector pushes wages in that sector upward, given the price of these tradable goods is determined by the world market. This, in turn, puts upward pressure on wages in the nontradable sector. But since productivity improvements in that sector are less than in the tradable sector, the price of nontradable goods must increase to compensate for the increase in wages. In this way, slower productivity growth in the non-tradable sector can increase the relative price of the nontradable goods.

Combining (2.3), (2.3)', (2.2) and (2.12)', we have:

$$\begin{aligned} q &= q_T + \alpha[\log(P_N/P_T)^{us} - \log(P_N/P_T)^{ca}] \\ &= q_T + \alpha[(\theta_{LN}/\theta_{LT}) \log(A_T^{us}/A_T^{ca}) - \log(A_N^{us}/A_N^{ca})] \qquad (2.13) \end{aligned}$$

or in growth form:

$$\begin{aligned} \hat{q} &= \hat{q}_T + \alpha [\widehat{(P_N/P_T)}^{us} - \widehat{(P_N/P_T)}^{ca}] \\ &= \hat{q}_T + \alpha[(\theta_{LN}/\theta_{LT})\widehat{(A_T^{us}/A_T^{ca})} - \widehat{(A_N^{us}/A_N^{ca})}] \qquad (2.13)' \end{aligned}$$

Suppose we assume that labour intensity in the nontradable sector is higher or equal to that in the tradable sector (i.e. $\theta_{LN} >= \theta_{LT}$), equation (2.13) implies that if the United States has relatively higher productivity in the tradable goods sector than Canada ($log(A_T^{us}/A_T^{ca}) > log(A_N^{us}/A_N^{ca})$), then the relative price of nontradable goods will be higher in the United States ($log(P_N/P_T)^{us} > log(P_N/P_T)^{ca}$). This in turn leads to a higher aggregate price level in the United States and a positive deviation from PPP (q>0). Equation (2.13)' indicates how differential growth in relative productivity can affect the movement of the real exchange rate. If the United States has relatively higher productivity growth in the tradable sector than Canada ($d\log(A_T^{us}/A_T^{ca}) > d\log(A_N^{us}/A_N^{ca})$) and again assuming $\theta_{LN} >= \theta_{LT}$, then it will experience a relatively higher increase in the price of nontradable goods. This, in turn, leads to an increase in the real exchange rate.

The Balassa-Samuelson model thus demonstrates how the presence of nontradable goods and productivity differentials between tradable and nontradable sectors can explain systematic departures of PPP at the aggregate level. We examine the B-S productivity effect on the real exchange rate in section 4.

3. *Testing the Law of One Price and Purchasing Power Parity*

This section examines the first hypothesis underlying the B-S model: PPP for tradable goods. In section 3.1, we provide a critical review of the literature and demonstrate that it could be misleading to use aggregate price indexes to test the law of one price (LOP) and the purchasing power parity (PPP). Section 3.2 introduces the data and section 3.3 provides empirical analysis.

3.1 Critical Literature Review

The PPP concept is important in that it is not only one of the key assumptions underlying many theoretical models in international economics, but it also has implications in evaluating a country's real income. This has motivated an extensive empirical literature that tests the PPP hypothesis. Dornbusch (1987), Froot and Rogoff (1995), and Rogoff (1996) provide excellent surveys of the literature on PPP. As they note, a large body of research has tested the PPP hypothesis by using aggregate price indexes, such as the consumer price index (CPI), the wholesale price index (WPI) and the producer price index (PPI). To increase the power of tests, many studies use either long-horizon time series (monthly or annual) or cross-country time series panel data. The econometric techniques for evaluating the PPP hypothesis have evolved from the simple OLS to more modern methods such as unit root and cointegration techniques to handle non-stationary time series data. The results are mixed and inconclusive. Some researchers did not find evidence of any convergence towards parity in the long run (e.g Huizinga 1987, Meese and Rogoff 1988). Even where evidence of parity is found in the long run (e.g. Abuaf and Jorion 1990, Frankel and Rose 1995, Lothian 1997, and Wei and Parsley 1995), the adjustment from short-run to the long-run equilibrium is a very slow process, at a half-life of 3-5 years.

Part of the explanation for the mixed empirical support for the PPP hypothesis may lie in the aggregation problem. The PPP hypothesis requires a comparison of aggregate prices using a common basket of goods with identical weights. The comparability of aggregate prices between countries depends on whether the commodities, and the weights assigned to them, are similar. In practice, aggregate price indexes, such as CPIs, typically involve somewhat different baskets of commodities across countries. The weights, derived from the expenditure patterns, differ and could change over time due to differences in taste, in the level of income and in the distribution of prices itself. This makes the testing of the PPP hypothesis with aggregate price indexes imperfect.

In addition, even with matched commodities and weights, it can still be misleading to use aggregate prices to test PPP. To demonstrate, suppose a country's overall price level (P) is a geometric mean of tradable (P_T) and nontradable (P_N) goods prices as in equation (2.1). Similarly, P_T and P_N are, in turn, geometric means of i tradable commodities and j nontradable commodities, respectively. Let α be the commodity expenditure shares, then

$$P = P_T^{(1-\alpha)} P_N^{\alpha} \quad \text{and} \tag{3.1}$$
$$P_T^{(1-\alpha)} = (P_{T1}^{\alpha T1} P_{T2}^{\alpha T2} \ldots P_{TI}^{\alpha TI}),\ \Sigma_i \alpha_{Ti} = (1-\alpha),\ i = 1 \ldots I \tag{3.2}$$
$$P_N^{\alpha} = (P_{N1}^{\alpha N1} P_{T2}^{\alpha N2} \ldots P_{NJ}^{\alpha NJ}),\ \Sigma_j \alpha_{Nj} = \alpha,\ j = 1 \ldots J \tag{3.3}$$

Take logs of equations (2.2) and (3.1)-(3.3), and assume that expenditure shares are the same in the two countries (i.e. $\alpha_{Ti}^{us} = \alpha_{Ti}^{ca}$ and $\alpha_{Nj}^{us} = \alpha_{Nj}^{ca}$ for all i and j).[4] We obtain:

$$q = (1-\alpha)q_T + \alpha q_N = \Sigma_i (\alpha_{Ti} q_{Ti}) + \Sigma_j (\alpha_{Nj} q_{Nj}) \quad (3.4)$$

where

$q = (\log P^{us} - \log P^{ca} - \log E)$
$q_{Ti} = (\log P_{Ti}^{us} - \log P_{Ti}^{ca} - \log E)$
$q_{Nj} = (\log P_{Nj}^{us} - \log P_{Nj}^{ca} - \log E)$
$\Sigma_i \alpha_{Ti} = (1-\alpha)$, $i = 1 \ldots I$ and $i \in$ tradable goods
$\Sigma_j \alpha_{Nj} = \alpha$, $j = 1 \ldots J$ and $j \in$ nontradable goods

Equation (3.4) indicates that the aggregate deviation from PPP (q) is a weighted average of PPP deviations of individual commodities. It is therefore possible to observe no significant PPP deviation at the aggregate level (i.e. q=0) even when there are large deviations from the law of one price at the individual commodity level. This could happen if some commodities are cheaper in the United States than in Canada (i.e. $q_{i,j} < 0$) while others are more expensive in the United States (i.e. $q_{i,j} > 0$). Similarly, any persistent and significant deviation from PPP at the aggregate level does not mean that the law of one price does not hold. As a simple illustration, suppose we have two groups of commodities: tradables and non-tradables. In that case, equation (3.4) shows that the aggregate real exchange rate (or deviations from PPP) is a weighted average of PPP deviations for the two groups. Since PPP is not likely to hold for nontradable goods and since around 55% of expenditures are for nontradables (Table 1), we are likely to observe deviations from PPP at the aggregate level even if PPP holds for tradable goods. A similar reasoning applies to any level of aggregated prices, including P_T and P_N. Therefore, it may be misleading to test PPP using aggregate price indexes. Ideally, one should test the law of one price by looking at individual commodity prices.

There are several studies that have evaluated the PPP hypothesis using disaggregated commodity prices. Rosenberg (1977) compares the c.i.f. (custom+insurance+freight) import prices from the United States, Europe and Japan for various steel products, and finds that relative dollar prices (i.e., the real exchange rate) are fairly constant over time. A number of other studies, however, have found surprisingly large price differentials, even for heavily tradable goods. Isard (1977) finds large price differences for a broad group of manufacturing goods. Giovannini (1988) finds a substantial deviation from the law of one price between the United States and Japan even for standardized manufactured commodities, such as nuts, bolts, and screws. A partial explanation for these deviations is that these manufactured tradable goods are more differentiated than the relatively homogeneous "steel products", or that the final price of these commodities may contain many non-tradable inputs, such as rents, utility, transport costs, retail and wholesale services. Richardson (1978), using monthly observations on Canadian and U.S commodity price indexes from 1965 to 1974, finds additional evidence that the law of one price can be rejected for Canada and the United States for such commodities as carbonated beverages, beer, cigarettes and cement. These commodities could be viewed as non-tradable goods due to trade barriers. Using

[4] The assumption of similar expenditure shares is a reasonable assumption. Table 1 compares the expenditure weights between the two countries.

prices of 10 matched Canadian/US industries over the period 1956-1975, Bordo and Choudhri (1977) show the importance of distinguishing different price behaviour between tradable and nontradable goods, and between homogeneous and heterogeneous goods.

In this paper, we adopt the micro approach, and contribute to the literature in two ways: by using a unique data set and a different empirical method. The Canada/U.S, micro data set used in the paper is far richer than any data set used in previous micro studies. It contains U.S./Canada relative prices on more than 168 matched goods and services, for four benchmark years (1985, 1990, 1993, and 1996). The time period covered in the data, 1985-1996, is of particular interest because it incorporates the introduction of the Canada-U.S Free Trade Agreement (FTA) in 1989 and the North American Free Trade Agreement (NAFTA) in 1994.[5]

However the data set also has its limitations. For each year we have 168 observations on U.S./Canada relative commodity prices. These prices are purchaser rather than producer prices. Thus, the change in the U.S./Canada relative prices may also reflect changes in the margins. Our analytical strategy is to divide the commodities into different groups and to study how prices behave differently across groups. In addition, we construct a time profile for each group based on observations over the four benchmark years (1985, 1990, 1993 and 1996). From the time profiles, we trace trends for each group and examine whether free trade has any impact on bilateral price differentials. We adopt several methods in our empirical investigation: analysis of variance, F-tests, T-tests, non-parametric Wilcoxon rank-sign tests, and correlation coefficient analysis.

[5] Under FTA, all tariffs on Canada and U.S. origin goods were eliminated on January 1, 1998 except for some agricultural products. NAFTA expands the free trade area to include Mexico and added free trade in other important sectors such as investment, trade in services, intellectual property, competition, cross-border movement of business persons and government procurement.

Table 1. Expenditure shares by group

YEAR	Commodity Group	Expenditure Canada	Expenditure United States	Total Expenditure Canada	Total Expenditure United States	Expenditure Share Canada	Expenditure Share United States
1985	1	$ 57,952	$ 515,340	$ 351,444	$ 3,037,584	0.16	0.17
1985	2	$ 101,507	$ 920,784	$ 351,444	$ 3,037,584	0.29	0.30
1985	3	$ 191,985	$ 1,601,460	$ 351,444	$ 3,037,584	0.55	0.53
1990	1	$ 75,226	$ 683,905	$ 506,694	$ 4,040,300	0.15	0.17
1990	2	$ 141,818	$ 1,179,027	$ 506,694	$ 4,040,300	0.28	0.29
1990	3	$ 289,650	$ 2,177,368	$ 506,694	$ 4,040,300	0.57	0.54
1993	1	$ 82,952	$ 759,553	$ 531,319	$ 4,496,495	0.16	0.17
1993	2	$ 134,422	$ 1,315,226	$ 531,319	$ 4,496,495	0.25	0.29
1993	3	$ 313,945	$ 2,421,717	$ 531,319	$ 4,496,495	0.59	0.54
1996	1	$ 88,065	$ 843,492	$ 593,628	$ 5,400,500	0.15	0.16
1996	2	$ 156,366	$ 1,674,973	$ 593,628	$ 5,400,500	0.26	0.31
1996	3	$ 349,197	$ 2,882,035	$ 593,628	$ 5,400,500	0.59	0.53

Groups: 1 - homogenous tradable; 2 - differentiated tradable; 3 – nontradable
Data source: Canada/U.S. bilateral price data set.

3.2 Data Source, Classification and Exploration

Data Source

The data used in the section is the Canada/U.S. price data set from the Income and Expenditure Accounts Division and the Prices Division at Statistics Canada. It contains Canada/U.S. bilateral price ratios and expenditures on 219 goods and services for each of four benchmark years—1985, 1990, 1993 and 1996. To make data more comparable, we concentrate on commodities used and produced in the business sector and exclude government (which includes medicare and health care) in the study. This results in a set of 168 commodities.

Commodity Groups Classification

For our purposes, there are two ways to divide commodities into groups. First, we classify the 168 commodities into tradable and nontradable goods, and classify tradables further into homogenous and differentiated categories. As a general rule, we classify the following commodities as nontradables: construction, tradable-restricted commodities (such as cigarettes, spirits & liquors, etc) and the majority of services. All the remaining are classified as tradables. Within tradables, those that are relatively homogeneous (such as food, fuel and power) are defined as homogeneous goods, and those that are relatively more heterogeneous in nature (such as clothes and footwear, household equipment and operation, and machinery and equipment) are defined as differentiated tradables.[6]

An alternative is to divide tradables and nontradables further into subgroups, which correspond roughly to the commodity groups used in the System of National Accounts. There are a total of 14 subgroups. The tradables include nine subgroups: food, alcohol and beverage, clothes and footwear, fuel and power, household equipment and operations, transportation and communication equipment, recreation equipment and books, miscellaneous goods, and machinery and equipment. The nontradables include five subgroups: restricted food, spirits and tobacco, various repairs, household services and rent, transportation and communication services, education, recreation and culture services, and construction. Appendix 1 provides a list of commodities and their groupings.

In this study, we focus our analysis on the three groups of commodities (homogeneous tradables, differentiated tradables and nontradables), and briefly present results for the 14 subgroups.

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[6] Needless to say, the assignment of the three categories, especially the homogeneous and differentiated commodities, is fairly subjective. But in the absence of hard, specific information on what goods belong to which category, the commodities are classified according to professional judgement, and with reference to available information on price dispersion. The 168 commodities come from benchmark years' surveys. The surveys contain price information of products with various specifications under each basic heading (i.e. a commodity). For example, under the basic heading "Rice", there are eight specifications of different types of rice. Hence we could calculate the dispersion of U.S./Canada relative prices for "Rice". Commodities with relatively lower price dispersions are more likely to be homogeneous commodities, and commodities with relatively higher price dispersions are more likely to be differentiated commodities.

Data Exploration

For each of the three groups of commodities, we have a time profile based on four-years of cross-sectional observations. This results in 12 cases (interaction between three groups and four years). Figure 2 plots the logged real exchange rates (q_i) for the 12 cases. Each plot shows the distribution of q_i, including the median (the middle line of the box), the upper quartile (the upper line of the box) and the lower quartile (the lower line of the box), and outliers. If the law of one price holds, then q_i, which measures the deviation from PPP, should equal zero. Several patterns emerge.

1. <u>The centre</u>. The median in each plot is close to zero, more so for homogeneous tradables, followed by differentiated tradables and non-tradables.
2. <u>The trend of the centre</u>. The median value of each group shares a similar trend: decreasing from 1985 to 1990, but increasing since 1990.
3. <u>The variability</u>. Most data are concentrated around zero. The variances are reasonably constant among the 12 cases.
4. <u>The outliers</u>. There are extreme values, marked by the sign of * and ^{o} in the plot. We define all values marked by * and two values marked by ^{o} as outliers. Table 2 provides a list of the identified 12 outliers.
5. <u>The distribution</u>. Under each case, the data appear to be normally distributed. This is further shown by the histograms (Figure 3). The horizontal line in the histogram indicates the value of the PPP deviation q_i. The vertical line indicates the frequency of occurrence of certain values. The shape of the histogram reveals that the data could be approximated by a normal distribution without outliers. Table 3 shows the Shapiro-Wilk normality test of q_i by group and by year. In more than half of the cases, the normality assumption is rejected at a confidence level of 95%. This could be due to the outliers as we see in the boxplots. Once we exclude the outliers, the normality assumption could not be rejected in general.

In summary, the real exchange rate for each commodity group is centred around zero and has a similar movement over time. In the next section, we test whether the deviations from zero are significant for each group, and whether there is a significant movement over time.

Table 2. Outliers of real exchange rates (in log form)

ID	YEAR	Commodity group	Commodity Sub-group	Commodity Code	Commodity Description	PUSCA	ERUSCA	Q	q
2	1985	1	1	2	Flour & Cereals	0.38	0.73	-0.35	-0.28
12	1985	1	1	13	Other Meat Preps	0.34	0.73	-0.39	-0.34
204	1996	1	1	35	Potatoes	2.03	0.73	1.30	0.44
45	1985	1	2	53	Other Tobacco	0.41	0.73	-0.32	-0.25
103	1990	1	2	53	Other Tobacco	0.33	0.86	-0.53	-0.41
442	1996	2	8	150	Personal Accessories	1.65	0.73	0.92	0.35
390	1993	2	9	191	Mach Tool - Met Wrk	1.44	0.77	0.67	0.27
448	1996	2	9	191	Mach Tool - Met Wrk	2.65	0.73	1.92	0.56
490	1985	3	10	124	Other Purch Transp	0.27	0.73	-0.46	-0.43
542	1990	3	10	124	Other Purch Transp	0.23	0.86	-0.63	-0.58
594	1993	3	10	124	Other Purch Transp	0.22	0.77	-0.55	-0.54
646	1996	3	10	124	Other Purch Transp	0.22	0.73	-0.51	-0.53

Note:

(1) For a list of commodity groups and sub-groups, see note to Appendix 1.
Group: 1=homogenous tradable goods 2=differentiated tradable goods 3=nontradable goods
Sub-group: 1=food 2=alcohol and beverage 8=miscellaneous goods 9=machinery and equipment (tradable goods) 10=restricted food, spirits, cigarettes (nontradable goods)

(2) PUSCA: relative U.S. price to Canadian price. PUSCA=P^{us}/P^{CA}
ERUSCA: U.S./CA exchange rate. ERUSCA=U.S. dollar/CA dollar
Q: real exchange rate. Q=PUSCA/ERUSCA
q: logged real exchange rate. q=log10(Q)

Figure 2. Boxplot of logged real exchange rate by group and year (with outlier)

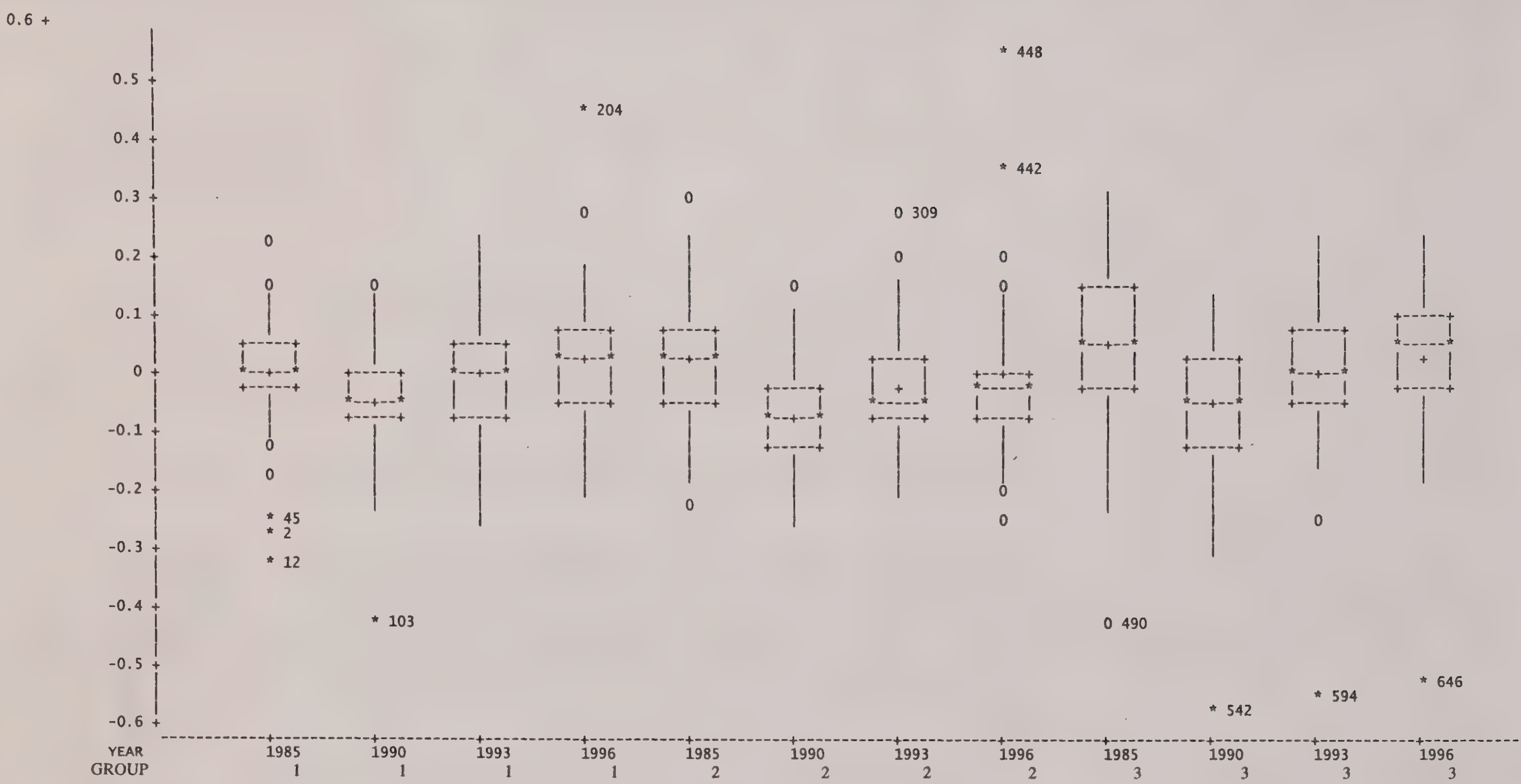
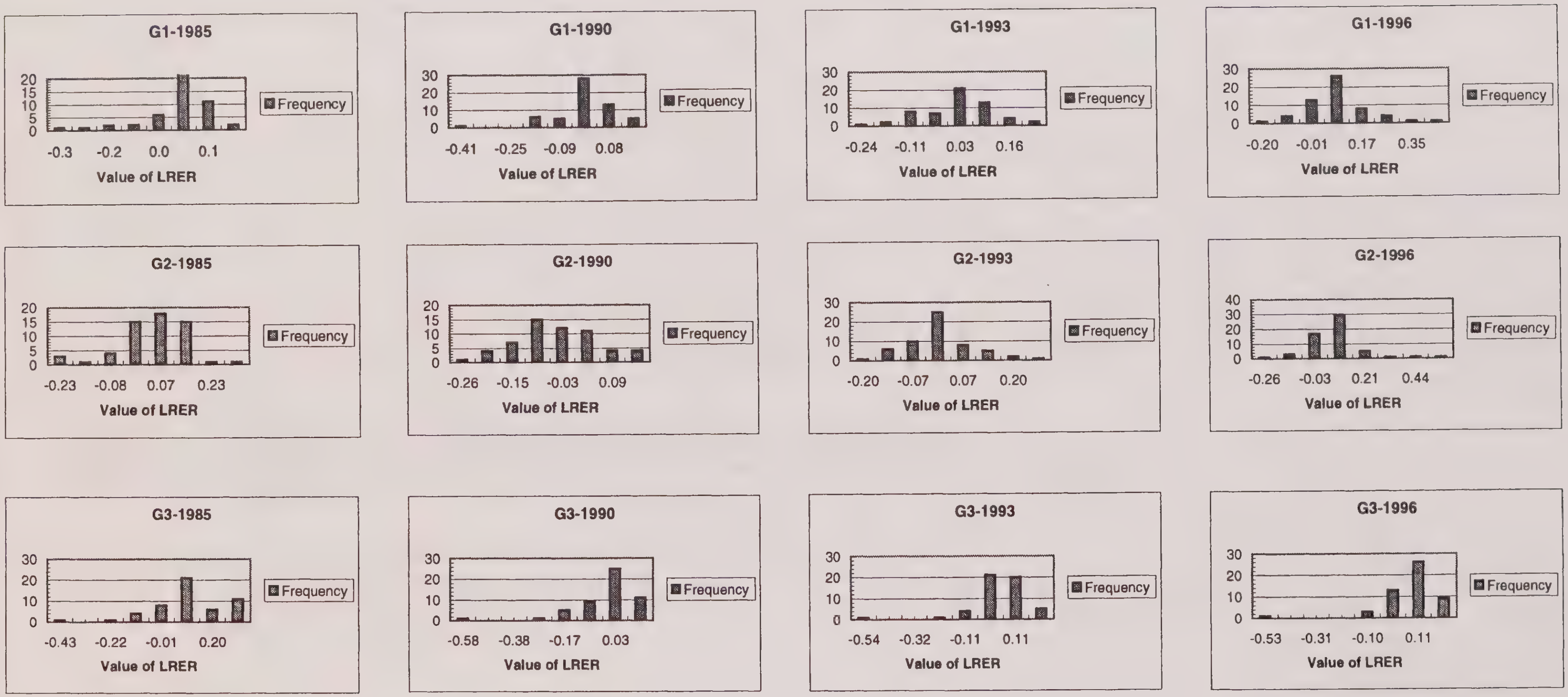


Figure 3. Histograms logged real exchange rate by group and by year (with outliers)



Note:
G1 - homogenous tradable goods
G2 - differentiated tradable goods
G3 - non-tradable goods

3.3 Empirical Analysis and Results

The basic test methodology is as follows. Suppose a group is composed of I commodities, and therefore there are I measures of PPP deviations (q_i, $i=1...I$ in a group). PPP deviation, q_i, indicates the extent of price differentials between the United States and Canada. A positive q_i means the commodity is relatively more expensive in the United States than in Canada, and a negative q_i means it is cheaper in the United States. If q_i for a given group follows a normal distribution—say $q_i \sim N\,(q_m, \sigma)$ with mean q_m and standard deviation σ—then we can rely on standard statistical tests such as t-tests and F-tests. The Shapiro-Wilk normality test (Table 3) indicates the normality assumption could not be rejected at a 95% confidence level once we exclude outliers. Empirical results without outliers are presented in section 3.3.1 to 3.3.4. To ensure our results are not contingent upon using a parametric distribution, we also performed non-parametric methods such as Wilcoxon rank-sign test. The non-parametric test does not require the normality assumption. This allows us to use all of the data including the outliers. The results are presented in section 3.3.5.

Table 3. Shapiro-Wilk normality test of logged real exchange rate (q)—by group

All Data		**1985**	**1990**	**1993**	**1996**	**All years**
G1	Normal	0.86	0.95	0.98	0.96	0.98
(homogenous tradables)	ProbN	0.00	0.02	0.59	0.10	0.15
G2	Normal	0.96	0.97	0.95	0.84	0.96
(differentiated tradables)	ProbN	0.12	0.48	0.04	0.00	0.00
G3	Normal	0.95	0.88	0.89	0.86	0.93
(nontradables)	ProbN	0.07	0.00	0.00	0.00	0.00
G1+G2	Normal	0.93	0.98	0.98	0.92	0.98
(all tradables)	ProbN	0.00	0.65	0.37	0.00	0.02
All groups	Normal	0.95	0.95	0.97	0.95	0.97
	ProbN	0.00	0.00	0.11	0.00	0.00
No outliers		**1985**	**1990**	**1993**	**1996**	**All years**
G1	Normal	0.96	0.97	0.98	0.99	0.98
(homogenous tradables)	ProbN	0.10	0.31	0.59	0.95	0.15
G2	Normal	0.96	0.97	0.97	0.96	0.98
(differentiated tradables)	ProbN	0.12	0.48	0.25	0.12	0.58
G3	Normal	0.96	0.94	0.98	0.98	0.97
(nontradables)	ProbN	0.15	0.03	0.88	0.84	0.08
G1+G2	Normal	0.96	0.98	0.98	0.98	0.98
(all tradables)	ProbN	0.01	0.33	0.44	0.73	0.16
All groups	Normal	0.95	0.97	0.98	0.99	0.98
	ProbN	0.00	0.12	0.21	0.84	0.00

3.3.1 Group and time effect on PPP

There are two potential factors that could affect the behaviour of the real exchange rate: time and group. We start the analysis by first examining whether these two factors and their interaction have any significant effect. That is: (a) Do real exchange rates behave differently across commodity groups? (b) Do they behave differently over time? (c) Does time have a differential effect, depending on which group the commodity belongs to? In other words, do real exchange rates in each group change differently over time?

These questions can be evaluated using the ANOVA (analysis of variance) method.[7] The ANOVA F-test is based on two basic assumptions: (i) each sample has a normal distribution, and (ii) the standard deviations are identical (equal variability). In this case, we have 12 samples (combination of three groups and four years). As the plots suggest and formal statistical tests (section 3.2) indicate, the normality and variability assumptions are reasonable and roughly satisfied by the data set without outliers.

The null hypothesis is that all samples have the same mean value. The alternative hypothesis is that they are not all the same, that is, at least two populations' means are different.

Table 4 presents the ANOVA results. The P-value for tests of the group-effect indicates that the real exchange rates differ significantly across commodity groups. The P-value for the time-effect also shows that time has a significant impact on the behaviour of the real exchange rate. However, their interaction term is not significant. This means that the effect of time on the real exchange rates does not vary significantly across groups.

In sum, the analysis of variance shows that the real exchange rate is significantly different across commodity groups and over time. However, the effect of time on the real exchange rate does not vary with groups. That is, average real exchange rates for different commodity groups move similarly over time.

Table 4. ANOVA test of group and time effect on logged real exchange rate

Source of Variation	DF	SS	F-Value	P-Value
Error or residual	648	5.67	--	--
Group	2	0.23	13.14	<0.001
Year	3	0.65	24.75	<0.001
Interaction: Group * Year	6	0.06	1.20	0.31

[7] ANOVA is used to test whether or not the averages from several different samples are significantly different from one another. It is essentially an F-test based on the F-statistic, a ratio of two variance measures. The numerator represents the between-sample variability, and the denominator represents the within-sample variability. If the ratio is larger than the value in the F-table, the effect is judged to be significant.

3.3.2 PPP by Commodity Group

Although the variance analysis helps us to identify the main effects of group and time, it does not reveal exactly *how* the real exchange rate behaves differently across commodity groups and through time. In this section, we examine the real exchange rates by commodity group.

We classify commodities into three groups: homogeneous tradables, differentiated tradables and nontradables. Suppose for each group, there are I commodities, therefore I measures of PPP deviation (q_i, $i=1...I$), where q_i follows a normal distribution ($q_i \sim N_{(q_m, \sigma)}$) with mean q_m and standard deviation σ. First we use a T-test to evaluate the PPP hypothesis for each group. The null hypothesis is that deviations for the group are, on average, not significantly different from zero (i.e. Ho: $q_m = 0$). For homogeneous goods, if the law of one price holds and if trade costs are negligible, then one may expect q_m to be not significantly different from zero. For differentiated goods produced under imperfect competition, differences in productivity and costs as well as 'pricing to market' and 'local currency pricing' are likely to lead to nonzero q_m .[8] For nontradable goods prices are likely to disobey the law of one price with impunity. Table 5 presents the group results, using observations over the entire time period.

The mean value of 0.02 for nontradable goods is significantly different from zero; thus the PPP hypothesis is rejected at the 5% level. PPP is also rejected at 5% level for tradable goods, which have a mean deviation of –0.02. This is consistent with Canzoneri's *et al* (1999) recent empirical findings that PPP does not hold even for tradable commodities.

However, as we classify tradables further into homogeneous and differentiated categories, we find that the average deviation of –0.003 for homogeneous tradables is not statistically different from zero, but that the mean value of –0.03 for differentiated tradables is significantly different from zero at the 5% level. This means that, within tradable goods, PPP is rejected for differentiated commodities, but not for homogeneous goods. The results are consistent with our prior expectation.

Second, we use a paired T-test to see if the three groups have significant differences in their price behaviour. The null hypothesis is that the average value of the real exchange rate for group i is not significantly different from group j (i.e. Ho: $q_i = q_j$, for $i \neq j$).

The results for the paired T-test are presented in Table 5. Means with the same letter are not significantly different from each other. For the three groups, the average real exchange rates are significantly different from each other. Thus they exhibit different behaviour.

Third, the mean values indicate the average price differentials between the United States and Canada. A positive/negative sign means that the commodity is more expensive/cheaper in the United States. For example, the mean value of the logged real exchange rate for homogeneous tradables over all years is –0.003. This indicates that on average the prices of tradable goods in the United States are 1% cheaper than in Canada over the four benchmark years. Table 5

[8] Thanks to Prof. Choudhri for making this point. For an overview of recent research on the structural explanations of PPP deviation, see Froot & Rogoff (1995) and Rogoff (1996).

calculates the percentage bilateral price differentials. It shows that tradables are on average cheaper in the States (with -1% and -7% respectively for homogeneous and differentiated tradables), while non-tradables are on average 4% more expensive in the States.

In sum, we find a significant deviation from PPP for both tradables and nontradables. The rejection of PPP for tradables could be due to the presence of differentiated commodities. This is confirmed by the data, which rejects PPP for the differentiated tradables but not for the homogenous tradables. This shows that empirical tests of PPP are contingent upon the choice of prices, and the level of aggregation. Just as the alleged size of the fish in a lake may depend on the net used to catch the fish (Eddington, 1928), the validity of PPP may depend upon the price data set used. As we pointed out in the previous section, it can be misleading to use aggregate prices to test the law of one price. The presence of nontradable goods and differentiated commodities make it possible for PPP not to hold at the aggregate level, even for tradable goods. This explains why PPP may fail even for highly tradable goods as found in Canzoneri *et al.* (1999).

Table 5. T-test and Paired T-test of logged real exchange rate—by group

Group	N	Mean	Std err (mean)	ProbT	Ho: q=0	Paired T-test	Price differential
1 homogeneous tradables	227	-0.003	0.006	0.60	Not	B	-1%
2 differentiated tradables	229	-0.03	0.006	0.001	reject	C	-7%
3 nontradables	204	0.02	0.008	0.03	reject	A	4%
1,2 tradables	456	-0.02	0.004	0.00	reject	--	-4%

3.3.3 PPP by group over Time

We next look in detail at the time profile of each group based on the observations over the four-benchmark years. Since the real exchange rate measures the price differentials, one would expect the absolute value of the logged real exchange rate (q_i) to fall if trade costs decline. Thus in the 1990s, with reduction in tariffs and other trade barriers between Canada and the United States, one may expect the following two trends.

First, the mean absolute value of the logged real exchange rate ($|q_m|$) is likely to fall in the 1990s for tradable goods. To measure whether q_m is significantly different from one period to the other, we perform the paired T-test for each group. The null hypothesis is that the average value of the real exchange rate in time t is not significantly different from that in time s.

Second, the dispersion of q_i for the tradable goods is likely to decrease.[9] The dispersion could be measured by the variance of q_i, which depends on trade costs b_i and random errors e_i. That is: $\text{var}(q_i) = \text{var}(b_i) + \text{var}(e_i)$ (assume b_i independent of e_i). One would expect $\text{var}(q_i)$ to decrease after FTA.

Table 6 presents results on the T-test, paired T-test, $|q_m|$ and $\text{var}(q_i)$. The results are as follows.

[9] Thanks to Professors Burns and Choudhri for this point.

1. For tradable homogeneous goods, the T-test rejects the PPP hypothesis for 1985 and 1990 at 5% level, but not for 1993 and 1996. The paired T-test further indicates that the average real exchange rates are significantly different between 1985 and 1990 and between 1990 and 1993, but not between 1993 and 1996. The absolute value of $|q_m|$ therefore decreased significantly from 0.04 in 1990 to 0.01 in 1993, but increased insignificantly from 0.01 in 1993 to 0.02 in 1996. This is consistent with the implication of reductions in trade costs. The variance of q_i is less consistent with our expectation. It increased from 1990 to 1993 and then decreased from 1993 to 1996. In general one could conclude that, for tradable homogenous commodities, prices between Canada and the United States are moving towards the law of one price over time, especially in the 1990s. This could be due to the general tendency of adjustment of prices over time, or due to the specific effect of reduced trade barriers in the 1990s between Canada and the United States.

2. For tradable differentiated goods, the PPP hypothesis is rejected at 5% level for all years except 1985. Though the deviations from PPP are significant in the 1990s, they have been falling significantly (in absolute value) from 0.07 in 1990 to 0.04 in 1993 and to 0.03 in 1996. The variance of q_i is also falling over time. These are consistent with our expectation.

3. For the tradable goods as a whole the PPP hypothesis is rejected for all four years except 1996. However, given that the price differentials between the two countries, for both the homogeneous and differentiated tradables, have been decreasing since 1990, the overall trend for tradable goods as a whole is also converging towards PPP. The mean deviation in absolute value has significantly decreased from 0.05 in 1990 to 0.02 in 1993 and to 0.003 in 1996. The variance of q_i is also falling over the 1990s for tradable goods as a whole. These declines are consistent with the general reduction in trade costs over the time period.

4. For nontradables, the PPP hypothesis is rejected for all years, except 1993. The deviations are significant. The price differentials fluctuate more wildly and do not present converging trends, as tradables do in the 1990s.

In sum, there is a tendency for the prices of homogeneous tradables to converge towards the law of one price in the 1990s. The price differentials for the differentiated tradables, though significantly different from zero between Canada and the United States, have experienced a significant reduction over the same period. This coincides with the time of increasing free trade between Canada and the United States in the 1990s.

Table 6. T-test and Paired T-test of logged real exchange rate over time (no outliers)

		1985	1990	1993	1996
G1 (homogenous tradable)	n	55	57	58	57
	Mean	0.02	-0.04	-0.01	0.02
	Std(mean)	0.01	0.01	0.01	0.01
	T	2.09	-3.36	-0.90	1.52
	ProbT	0.04	0.00	0.37	0.14
	Paired T-test	A	B	A	A
	Var(q)	0.0043	0.0081	0.0102	0.0095
	Price differentials	4%	-8%	-3%	5%
G2 (differentiated tradable)	N	58	58	57	56
	Mean	0.01	-0.07	-0.04	-0.03
	Std(mean)	0.01	0.01	0.01	0.01
	T	1.09	-5.91	-3.21	-2.19
	ProbT	0.28	0.00	0.00	0.03
	Paired T-test	A	C	B	B
	Var(q)	0.0106	0.0134	0.0081	0.0080
	Price differentials	3%	-15%	-8%	-6%
G3 (nontradables)	n	51	51	51	51
	Mean	0.06	-0.05	0.01	0.04
	Std(mean)	0.02	0.01	0.01	0.01
	T	3.58	-3.44	0.65	3.57
	ProbT	0.00	0.00	0.52	0.00
	Paired T-test	A	C		A
				B	B
	Var(q)	0.0203	0.0113	0.0088	0.0090
	Price differentials	16%	-10%	2%	10%
G1 + G2 (Tradables)	n	113	115	115	113
	Mean	0.02	-0.05	-0.02	0.00
	Std(mean)	0.01	0.01	0.01	0.01
	T	2.02	-6.55	-2.72	-0.31
	ProbT	0.05	0.00	0.01	0.76
	Paired T-test	A	C		A
				B	B
	Var(q)	0.0076	0.0108	0.0091	0.0088
	Price differentials	4%	-12%	-5%	-1%
All groups	N	164	166	166	164
	Mean	0.03	-0.05	-0.01	0.01
	Std(mean)	0.01	0.01	0.01	0.01
	T	3.88	-7.34	-1.87	1.56
	ProbT	0.00	0.00	0.06	0.12
	Paired T-test	A	C	B	A
	Var(q)	0.0115	0.0109	0.0090	0.0088
	Price differentials	7%	-11%	-3%	3%

Note:

(1) Means with the same letter are not significantly different at alpha=0.05.

(2) Similar results are obtained using Duncan's multiple range test and Turkey's studentized range test as paired T-test.

(3) Var(q): variance of logged real exchange rate. $Var(q)=\Sigma_i(q_i)^2$.

(4) Price differentials: U.S. more expensive (positive) and cheaper (negative).

3.4.4 PPP by sub-group

We next briefly examine the price behaviour of the 14 subgroups. Table 7 presents the Shapiro-Wilk normality test, which shows that the normality assumption for each subgroup over time is reasonable. Table 8 contains the t-test. The main findings are as follows.

For tradable subgroups, purchasing power parity is strongly rejected at the 1% level for alcohol and beverages, fuel and power, household equipment and operation, and recreation equipment and books. It is weakly rejected at 10% for machinery and equipment, and other miscellaneous commodities. The average price over the four years is significantly higher in Canada than in the United States for all of the above subgroups, except fuel and power. However, PPP could not be rejected for other tradable subgroups such as food, clothes and footwear, and transportation equipment.

Table 7. Shapiro-Wilk normality test by subgroup

		1985	1990	1993	1996	All years
Tradable subgroups (1-9)						
SG1	Normal	0.95	0.97	0.96	0.98	0.98
Food	ProbN	0.09	0.37	0.25	0.87	0.31
SG2	Normal	0.87	0.81	0.86	0.90	0.94
Alcohol & beverage	ProbN	0.27	0.10	0.17	0.36	0.18
SG3	Normal	0.83	0.93	0.94	0.94	0.96
Clothes & footwear	ProbN	0.07	0.51	0.60	0.64	0.42
SG4	Normal	0.97	0.95	0.96	0.93	0.96
Fuel & power	ProbN	0.85	0.71	0.80	0.63	0.58
SG5	Normal	0.94	0.92	0.91	0.91	0.98
Household equipment and operation	ProbN	0.40	0.15	0.10	0.12	0.47
SG6	Normal	0.89	0.92	0.82	0.90	0.97
Transportation and communication equipment	ProbN	0.36	0.52	0.12	0.41	0.67
SG7	Normal	0.97	0.96	0.91	0.92	0.98
Recreation equipment and books	ProbN	0.82	0.74	0.22	0.33	0.77
SG8	Normal	0.69	0.88	0.89	0.97	0.91
Miscellaneous goods	ProbN	0.01	0.30	0.37	0.79	0.09
SG9	Normal	0.92	0.94	0.94	0.85	0.97
Machinery and equipment	ProbN	0.10	0.25	0.22	0.00	0.19
Nontradable subgroups (10-14)						
SG10	Normal	0.98	0.82	0.97	0.98	0.93
Restricted food, spirits, cigarettes	ProbN	0.87	0.05	0.88	0.97	0.51
SG11	Normal	0.96	0.94	0.90	0.91	0.94
Various repairs, household services, rent	ProbN	0.02	0.19	0.03	0.04	0.22
SG12	Normal	0.90	0.72	0.92	0.93	0.93
Transportation and communication services	ProbN	0.02	0.01	0.54	0.58	0.61
SG13	Normal	0.94	0.94	0.90	0.96	0.93
Education, recreation and culture services	ProbN	0.15	0.68	0.38	0.79	0.59
SG14	Normal	0.95	0.71	0.97	0.94	0.90
Construction	ProbN	0.15	0.00	0.92	0.51	0.23

Table 8. T-test of real exchange rate by sub-group (no outliers)

Tradable Sub-groups		1985	1990	1993	1996	All years	H0: q=0
SG1	N	37	39	39	38	153	
Food	Mean	0.02	-0.04	-0.01	0.03	0.00	
	Std(mean)	0.01	0.01	0.02	0.02	0.01	not reject
	ProbT	0.04	0.00	0.69	0.10	0.98	
	Price differential	5%	-9%	-2%	7%	0.04%	
SG2	N	5	5	6	6	22	
Alcohol and beverage	Mean	-0.01	-0.10	-0.09	-0.06	-0.07	
	Std(mean)	0.05	0.04	0.04	0.03	0.02	reject
	ProbT	0.88	0.06	0.05	0.10	0.00	
	Price differential	-2%	-21%	-19%	-14%	-14%	
SG3	N	8	8	8	8	32	
Clothes and footwear	Mean	-0.02	-0.03	-0.01	0.01	-0.01	
	Std(mean)	0.02	0.02	0.02	0.02	0.01	not reject
	ProbT	0.30	0.08	0.71	0.71	0.13	
	Price differential	-4%	-7%	-2%	1%	-3%	
SG4	N	5	5	5	5	20	
Fuel and power	Mean	0.08	0.04	0.03	0.07	0.06	
	Std(mean)	0.02	0.03	0.03	0.03	0.01	reject
	ProbT	0.02	0.27	0.36	0.09	0.00	
	Price differential	21%	11%	8%	17%	14%	
SG5	N	16	16	16	16	64	
Household equipment	Mean	0.03	-0.11	-0.06	-0.02	-0.04	
and operation	Std(mean)	0.02	0.03	0.02	0.02	0.01	reject
	ProbT	0.11	0.00	0.04	0.46	0.00	
	Price differential	7%	-23%	-12%	-4%	-9%	
SG6	N	5	5	5	5	20	
Transportation and	Mean	0.02	-0.07	-0.02	-0.02	-0.02	
communication	Std(mean)	0.03	0.04	0.04	0.04	0.02	not reject
equipment	ProbT	0.54	0.20	0.74	0.67	0.31	
	Price differential	4%	-14%	-3%	-4%	-4%	
SG7	N	11	11	11	11	44	
Recreation equipment	Mean	0.05	-0.12	-0.05	-0.02	-0.03	
and books	Std(mean)	0.03	0.02	0.02	0.02	0.01	reject
	ProbT	0.19	0.00	0.06	0.48	0.03	
	Price differential	11%	-23%	-11%	-4%	-7%	
SG8	N	5	5	5	4	19	
Miscellaneous goods	Mean	-0.11	-0.07	-0.01	0.00	-0.05	
	Std(mean)	0.08	0.04	0.04	0.04	0.03	not reject
	ProbT	0.25	0.14	0.79	0.97	0.08	
	Price differential	-22%	-16%	-3%	0%	-11%	
SG9	N	21	21	20	20	82	
Machinery and	Mean	0.02	-0.02	-0.02	-0.04	-0.02	
equipment	Std(mean)	0.02	0.02	0.02	0.02	0.01	not reject
	ProbT	0.47	0.30	0.16	0.05	0.08	
	Price differential	4%	-4%	-5%	-9%	-4%	

Table 8. (Cont'd) T-test of real exchange rate by subgroup (no outliers)

Nontradable Subgroups		1985	1990	1993	1996	All years	H0: q=0
SG10 Restricted food, spirits, cigarettes	N	8	8	8	8	32	reject
	Mean	-0.03	-0.13	-0.07	-0.01	-0.06	
	Std(mean)	0.04	0.04	0.04	0.02	0.02	
	ProbT	0.44	0.02	0.11	0.68	0.00	
	Price differential	-7%	-26%	-15%	-2%	-13%	
SG11 Various repairs, household services, rent	N	21	21	21	21	84	not reject
	Mean	0.02	-0.06	0.00	0.04	0.003	
	Std(mean)	0.02	0.02	0.01	0.02	0.01	
	ProbT	0.31	0.00	1.00	0.02	0.79	
	Price differential	6%	-13%	0%	11%	1%	
SG12 Transportation and communication services	N	6	6	6	6	24	reject
	Mean	0.08	-0.01	0.02	0.04	0.03	
	Std(mean)	0.04	0.02	0.02	0.03	0.02	
	ProbT	0.12	0.51	0.50	0.25	0.06	
	Price differential	19%	-3%	4%	11%	7%	
SG13 Education, recreation and culture services	N	7	7	7	7	28	reject
	Mean	0.07	-0.03	0.04	0.07	0.04	
	Std(mean)	0.03	0.05	0.04	0.04	0.02	
	ProbT	0.04	0.64	0.34	0.10	0.06	
	Price differential	16%	-6%	11%	19%	10%	
SG14 Construction	N	10	10	10	10	40	reject
	Mean	0.20	0.02	0.04	0.05	0.08	
	Std(mean)	0.04	0.02	0.03	0.03	0.02	
	ProbT	0.00	0.35	0.24	0.12	0.00	
	Price differential	58%	4%	9%	13%	19%	

For nontradable subgroups, PPP is rejected for trade-restricted food-spirits-tobacco[10], transportation and communication services, education, recreation and cultural services, and construction. The average prices over the four years are significantly lower in Canada than in the States for these subgroups, except restricted food-spirits-tobacco. For other nontradable subgroups, i.e. various repairs, household services and rent, the deviations from PPP are not significantly different from zero.

[10] Note that the average prices for trade-restricted food-spirits-tobacco are higher in Canada than in the U.S. This may be a result of using purchaser rather than producer prices. The purchaser prices include exercise taxes.

3.4.5 Non-parametric tests

To ensure that our conclusions are not contingent upon our parametric distribution and the exclusion of outliers, we also perform non-parametric tests (Wilcoxon's sign-test, rank-sum test, and paired sign test). The non-parametric tests do not require normal distribution[11], and hence allow us to use all the data, including the outliers. The non-parametric test yields similar results to the parametric tests. Test statistics are summarized in tables 9 and 10.

Table 9. Nonparametric Sign Test—by group

		1985	1990	1993	1996	All years	H0: q=0	Paired T-Test
G1	MSIGN	5.00	-12.00	0.00	5.00	-2.00	not reject	B
(Homogenous tradable)	PROBM	0.24	0.00	1.00	0.24	0.84		
	PAIRED SIGN TEST	A		A	A			
			B	B				
G2	MSIGN	6.00	-16.00	-13.00	-12.00	-35.00	reject	C
(Differentiated tradable)	PROBM	0.15	0.00	0.00	0.00	0.00		
	PAIRED SIGN TEST	A	C	B	A			
G3	MSIGN	12.00	-6.00	-1.00	10.00	15.00	reject	A
(Nontradable)	PROBM	0.00	0.13	0.89	0.01	0.04		
	PAIRED SIGN TEST	A	C	B	A			
G1+G2	MSIGN	11.00	-28.00	-13.00	-7.00	-37.00	reject	
(All tradable)	PROBM	0.05	0.00	0.02	0.23	0.00		
	PAIRED SIGN TEST	A	C	B	A			
All groups	MSIGN	23.00	-34.00	-14.00	3.00	-22.00	not reject	
	PROBM	0.00	0.00	0.04	0.70	0.10		
	PAIRED SIGN TEST	A	C	B	A			

Note: the rank-sum test has the same result as the sign test.

[11] Nonparametric tests do not require a normal distribution because they are based on counts or ranks instead of the actual data values. When the sample of data is normally distributed, we use the average and standard error to test the population mean. The nonparametric approach tests the population median.

The sign test essentially decides whether the population median is equal to a given reference value (which is zero PPP deviation here) based on the number of sample values that fall below that reference value, and on the fact that the number of sample data values below a continuous population's median follows a binomial distribution. The paired sign-test is used to test whether two columns of values are significantly different. It is essentially a sign test of the differences.

For more detailed references, see Lehmann and D'Abrera (1975) and Randles and Wolfe (1979).

Table 10. Nonparametric Sign test—by tradable subgroup

		1985	1990	1993	1996	All years
SG1 Food	MSIGN	4.50	-7.50	1.50	4.50	3.00
	PROBM	0.20	0.02	0.75	0.20	0.69
SG2 Alcohol and beverage	MSIGN	0.00	-3.00	-3.00	-2.00	-8.00
	PROBM	1.00	0.03	0.03	0.22	0.00
SG3 Cothes and footwear	MSIGN	-2.00	-2.00	0.00	1.00	-3.00
	PROBM	0.29	0.29	1.00	0.73	0.38
SG4 Fuel and power	MSIGN	2.50	0.50	1.50	1.50	6.00
	PROBM	0.06	1.00	0.38	0.38	0.01
SG5 Household equipment and operation	MSIGN	2.00	-6.00	-5.00	-4.00	-13.00
	PROBM	0.45	0.00	0.02	0.08	0.00
SG6 Transportation and communication equipment	MSIGN	1.50	-1.50	-1.50	-1.50	-3.00
	PROBM	0.38	0.38	0.38	0.38	0.26
SG7 Recreation equipment and books	MSIGN	1.50	-5.50	-3.50	-1.50	-9.00
	PROBM	0.55	0.00	0.07	0.55	0.01
SG8 Miscellaneous goods	MSIGN	-0.50	-0.50	-0.50	0.50	-1.00
	PROBM	1.00	1.00	1.00	1.00	0.82
SG9 Machinery and equipment	MSIGN	1.50	-2.50	-2.50	-5.50	-9.00
	PROBM	0.66	0.38	0.38	0.03	0.06
Nonparametric Sign test - by nontradable subgroup						
		1985	**1990**	**1993**	**1996**	**All years**
SG10 Restricted food, spirits, cigarettes	MSIGN	-2.00	-3.00	-2.00	-1.00	-8.00
	PROBM	0.29	0.07	0.29	0.73	0.01
SG11 Various repairs, household services, rent	MSIGN	4.50	-5.50	-1.50	5.50	3.00
	PROBM	0.08	0.03	0.66	0.03	0.59
SG12 Transportation and communication services	MSIGN	3.00	0.00	0.00	1.00	4.00
	PROBM	0.03	1.00	1.00	0.69	0.15
SG13 Education, recreation and culture services	MSIGN	2.50	0.50	1.50	2.50	7.00
	PROBM	0.13	1.00	0.45	0.13	0.01
SG14 Construction	MSIGN	4.00	2.00	1.00	2.00	9.00
	PROBM	0.02	0.34	0.75	0.34	0.01

4. The Differential Productivity Effect

In this section, we examine the productivity effect of the B-S model. As equation (2.13) indicates, if the United States has relatively higher productivity in the tradable sector than Canada ($log(A_T^{us}/A_T^{ca})>log(A_N^{us}/A_N^{ca})$) and if we assume the non-tradable sector is more labour-intensive than the tradable sector, then the relative price of nontradable goods ($log(P_N/P_T)^{us}>log(P_N/P_T)^{ca}$) and the aggregate price level will be higher in the United States. It therefore predicts positive relationships among relative productivity differentials ($log(A_T^{us}/A_T^{ca})/(A_N^{us}/A_N^{ca})$), relative price differentials ($log(P_N/P_T)^{us}/(P_N/P_T)^{ca}$) and the real exchange rate (q).

The empirical evidence on the B-S model is mixed. Froot and Rogoff (1991) and Asea and Mendoza (1994) find little support. However, Martson (1987), De Gregorio, Giovannini, and Wolf (1994), Rogers and Jenkins (1995), and Canzoneri *et al.* (1999) find some support of the B-S productivity effect for the OECD countries. In a recent study by Canzoneri *et al.* (1999), they test the two underlying hypotheses using a panel of OECD countries. Their results are less favourable to the PPP hypothesis for tradable goods, but suggest that in the long run relative prices generally reflect relative labour productivity.

In what follows, we examine the B-S's productivity hypothesis. We first use the four benchmark years data, then extend it to a longer time series.

4.1 Empirical analysis based on four benchmark years

Data

We use the Multi-Factor Productivity estimates (MFPs) of the manufacturing and non-manufacturing business sectors as proxies for the MFPs of the tradable and nontradable sectors respectively. The data for Canada and the U.S are from Statistics Canada and Bureau of Labor Statistics Productivity Programs respectively.

The data used include comparable measures of real value-added output, capital stock, hours worked and cost of inputs for the manufacturing and the business sectors. MFP growth for the manufacturing sector is calculated as the difference between real value-added output growth and cost-share weighted input growth (capital stock and labour hours). The MFP for the non-manufacturing sector is calculated as follows. Assume that the MFP for the business sector is a weighted average of the MFPs of the manufacturing and non-manufacturing sectors. That is: $A_B=\alpha A_M+(1-\alpha)A_N$, where α is the manufacturing value-added output share in the business sector, and A_i is the MFP for sector i ($i=B, M, N$ which stand for business, manufacturing, and non-manufacturing sectors respectively). Thus $A_S=(A_B-\alpha A_N)/(1-\alpha)$.

[12] MEAD has MFPs for the business goods sector and the business service sector for Canada, but we do not have comparable figures for the United States. To maintain comparability, we use the same method to calculate the approximated MFPs for the tradable and nontradable sectors for both countries.

The relative price differentials ($log(P_N/P_T)^{us}/(P_N/P_T)^{ca}$) are calculated as Fisher-weighted averages of individual commodities[13], using the Canada/U.S bilateral price data set mentioned in section 3.2.

Empirical Results

Figure 4 plots the real exchange rate, the relative price differential ($log(P_N/P_T)^{us}/(P_N/P_T)^{ca}$) and the relative productivity differential ($log(A_T^{us}/A_T^{ca})/(A_N^{us}/A_N^{ca})$) for the four-benchmark years. Several observations are in order:

First, we notice that the relative price differentials always exceed zero. This means the relative price of nontradable to tradable goods is higher in the United States than in Canada.

Second, the movement in the aggregate real exchange rate (q) is closely correlated (with a correlation coefficient of 0.81) to the movement in the relative price differential ($log(P_N/P_T)^{us}/(P_N/P_T)^{ca}$). This is consistent with our expectations, but contrasts with Engel's (1999) finding. Engel examines real exchange rate movements of the U.S relative to a number of other high-income countries from one month up to 30 years. He finds that "relative prices of nontradable goods appear to account for almost none of the movements of U.S exchange rates".

Third, the correlation between the relative price differential and the relative productivity differential is –0.33 and the correlation between the relative productivity differential and the real exchange rate is –0.52. The negative correlation runs counter to the B-S prediction. However, once we drop 1985 and only examine the relationship in the 1990s, we obtain a correlation with the expected sign: 0.94 for the relative productivity differential and the relative price differential, and 0.02 for the relative productivity differential and the real exchange rate.

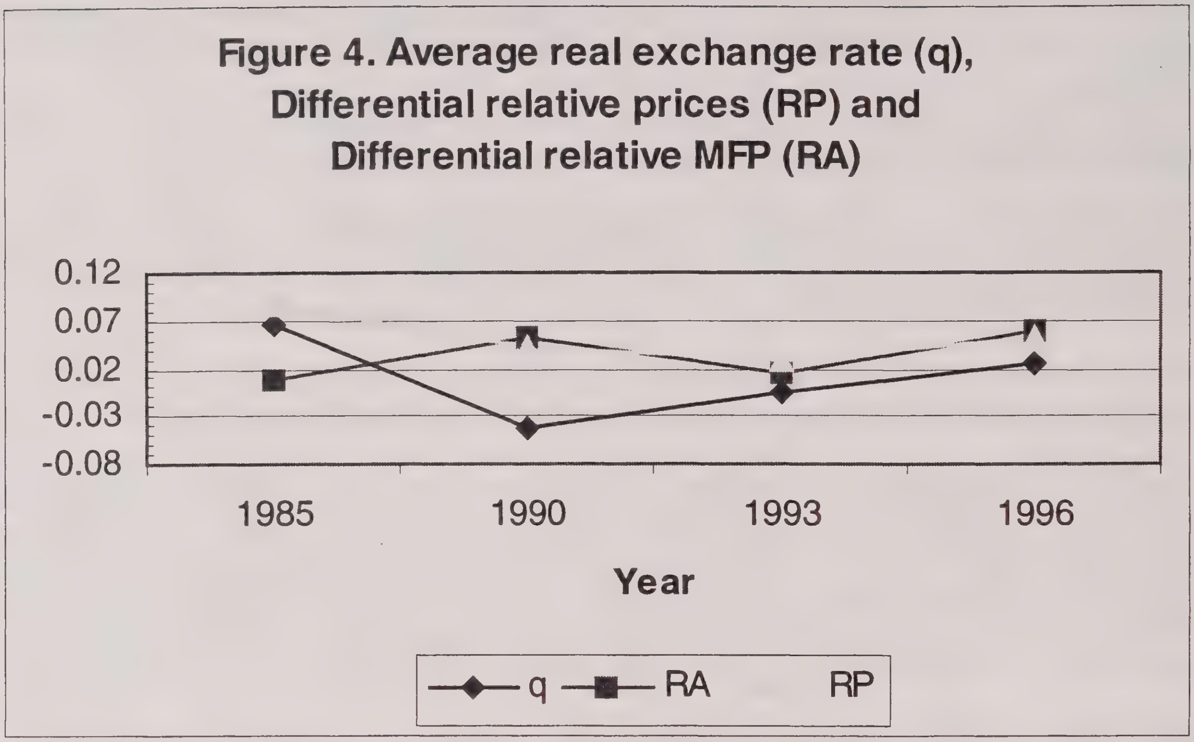
The above results provide no evidence for the B-S prediction. The B-S's productivity effect on the real exchange rate is based on the assumption that PPP holds for tradable goods. As section 3.3.3 demonstrates, the prices for tradable goods between the two countries, though not equalized, are converging towards parity in the 1990s.

[13] Here, we define $(P^{us}/P^{ca})_g{}^L = \Sigma_i P^{us}Q^{ca} / \Sigma_i P^{ca} Q^{ca}$

$(P^{us}/P^{ca})_g{}^P = \Sigma_i P^{us}Q^{us} / \Sigma_i P^{ca} Q^{us}$

$(P^{us}/P^{ca})_g{}^F = [(P^{us}/P^{ca})_g{}^L]^{1/2} [(P^{us}/P^{ca})_g{}^P]^{1/2}$

$i \in g$, g=tradable, nontradable, business sector, where I is commodity, $(P^{us}/P^{ca})_g{}^L$, $(P^{us}/P^{ca})_g{}^P$, $(P^{us}/P^{ca})_g{}^F$ are Laspeyres, Pasasche and Fisher implicit price indexes (here the relative price ratios) for group g respectively. For detailed formulas, see Kemp (1993).



Note:

- q is the logged real exchange rate. The real exchange rate is the relative price of US (P^{US}) to Canada (P^{CA}) adjusted by nominal exchange rate (*E*: the ratio of US dollar to Canadian dollar). That is $q = log(P^{US}/(P^{CA}E))$.
- RA is the logged ratio of relative productivity of tradable to nontradable sector in the US and that in the Canada. That *is* $RA = log[(A_T/A_N)^{US}/(A_T/A_N)^{CA}]$, where A_T and A_N stand for productivity for the tradable and nontradable sectors respectively.
- RP is the logged ratio of relative price of nontradable to tradable sector in the US and that in the Canada. That is $RP = log[(P_N/P_T)^{US}/(P_N/P_T)^{CA}]$, where P_T and P_N stand for productivity for the tradable and nontradable sectors respectively.

4.2 A preliminary exploration using longer time series data

So far we have only looked at the movements of price, productivity and the real exchange rate in four years. To see if there is any long-run relationship between the real exchange rate and the productivity, we look at longer time series data (1981-1996). The time-series data for the real exchange rate are from the National Accounts Division at Statistics Canada.[14] It is calculated using U.S/Canada relative price ratio at GDP aggregate level adjusted by nominal exchange rate. The MFPs are the same as in section 4.1.

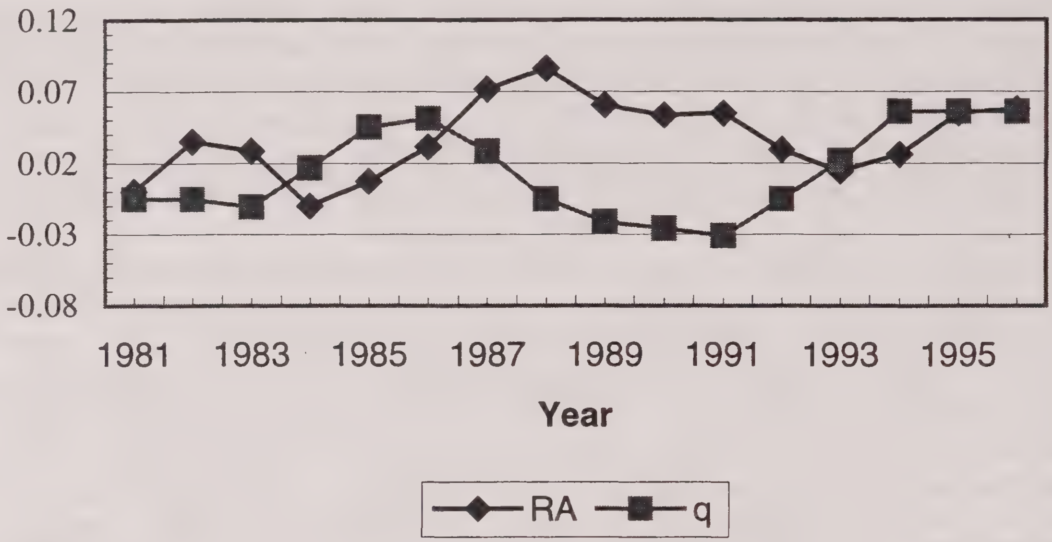
[14] They are essentially extrapolated from the benchmark relative prices using percentage changes in the implicit price indexes. For detailed description and data, see Kemp (1993).

Figure 5 plots the real exchange rate and the relative productivity differentials for the period 1981-1996. We divide the period into three sub-periods: 1981-1986, 1986-1991, and 1991-1996. The dividing line corresponds to turning points of the cycle in the appreciation and depreciation of the Canadian dollar in relation to the U.S dollar. The correlation between the relative productivity differential and the real exchange rate is –0.05, -0.31 and 0.05 for the three sub-periods respectively. However, they are very sensitive to how we divide the three sub-periods. If we choose 1987 and 1992 as dividing years instead of 1986 and 1991, the correlation becomes 0.12, 0.32 and 0.58 for the three sub-periods 1981-1987, 1987-1992, and 1992-1996 respectively. With this lag, one observes that the correlation between the two variables has the expected positive sign in the 1990s. This is consistent with our results in section 4.1 using four years of observations and consistent with Balassa-Samuelson's productivity hypothesis.

What is perhaps more noteworthy is that the real exchange rate and relative productivity are often moving in opposite directions during certain periods. More importantly, there is a distinct lag pattern with relative productivity following the real exchange rate. Under Balassa-Samuelson's hypothesis, the real exchange rate is determined by the exogenous changes in the relative productivity differentials. That is, if the home country has a relatively higher productivity growth in the tradable sector (or relatively lower productivity growth in the nontradable sector) than a foreign country, the comparative price level at home (i.e. prices adjusted by nominal exchange rate) will grow faster than in the foreign country. Thus the causality runs from the relative productivity differentials to the real exchange rate. However, in Figure 5 the relative productivity differential lags behind the real exchange rate by approximately one to two years. This suggests the possibility that the fluctuation in the real exchange rate, or more likely in the nominal exchange rate[15], may have a reverse impact on the relative productivity growth. To see this intuitively, consider the period of 1987-1992 when the Canadian dollar depreciates. With the appreciation of the Canadian dollar, the cost of capital goods becomes cheaper in Canada than in the US. The lower cost of capital goods induces higher investment. Since the tradable sector is more capital intensive than the nontradable service sector, we might expect productivity growth of the tradable sector to the nontradable sector in Canada to be higher than that in the U.S. This is indeed what has happened in the period of 1987-1992 when we observe declining relative productivity differentials ($log[(A_T^{us}/A_T^{ca})/(A_N^{us}/A_N^{ca})]$) in Figure 5.

[15] This is so because as Figure 1 indicates, the movements in the real exchange rate mainly reflects the movement in the nominal exchange rate while the relative prices in own currency remain relatively stable over the period 1981-1996.

Figure 5. Real exchange rate (q) and differential relative MFP (RA)



Note:

- q is the logged real exchange rate. The real exchange rate is the relative price of US (P^{US}) to Canada (P^{CA}) adjusted by nominal exchange rate (E: the ratio of US dollar to Canadian dollar). That is $q = log(P^{US}/(P^{CA}E))$.
- RA is the logged ratio of relative productivity of tradable to nontradable sector in the US and that in the Canada. That *is* $RA = log[(A_T/A_N)^{US}/(A_T/A_N)^{CA}]$, where A_T and A_N stand for productivity for the tradable and nontradable sectors respectively.

5. Conclusion

The paper examines possible explanations for deviations from purchasing power parity (PPP) between Canada and the United States in the 1980s and 1990s. The Balassa-Samuelson (B-S) model is used as the basis for the empirical exercise. In the B-S model, where PPP is assumed to hold for tradable goods, the changes in the real exchange rate (or the price differentials between countries) reflects changes in the relative productivity of the tradable and nontradable sectors between countries. We investigate both the productivity effect and the underlying assumption of PPP for tradable goods.

We find that purchasing power parity is rejected for both tradables and nontradables. Within tradables, however, PPP could not be rejected for homogeneous goods, though it is rejected for differentiated commodities. The results highlight that care must be taken to distinguish between different commodity groups when evaluating the PPP hypothesis. The presence of heterogeneous commodity groups can invalidate the law of one price at the aggregate level.

We also find that bilateral prices (adjusted by exchange rate) for tradables are converging towards parity in the 1990s. This coincides with a period of increasing free trade between Canada and the United States.

Finally, we find a relationship between the real exchange rate and relative productivity but not one that fits with a simple Balassa-Samuelson model. It appears that changes in relative productivity follow changes in the real exchange rate, rather than the reverse.

Appendix 1: List of Commodities and Groupings

CAT	PE	= Personal expenditure
	GE	= Government expenditure
	KFME	= Capital formation (Machinery and Equipment)
	KFCON	= Capital formation (Construction)
	KFOTH	= Capital formation (other)
	KSC	= Capital Stock change
	NEXP	= Next export
GROUP	1	= homogenous tradable goods
	2	= differentiated tradable goods
	3	= non-tradable goods
SUBGROUPS		
Tradables	1	= food
	2	= alcohol and beverage
	3	= clothes and footwear
	4	= fuel and power
	5	= household equipment and operation
	6	= transportation and communication equipment
	7	= recreation equipment and books
	8	= miscellaneous goods
	9	= machinery and equipment
Nontradables	10	= restricted food, spirits, cigarettes
	11	= various repairs, household services, rent
	12	= transportation and communication services
	13	= education, recreation and culture services
	14	= construction

Cat	GROUP	SUBGROUP	DCCODE	DCNAME	ACCODE	ACNAME
PE	1	1	1	Rice	4	Bread & Cereals
PE	1	1	2	Flour & Cereals		
PE	1	1	3	Bread		
PE	1	1	4	Other Bakery		
PE	1	1	5	Pasta Products		
PE	1	1	6	Other Cereals		
PE	1	1	7	Beef	5	Meat
PE	1	1	8	Veal		
PE	1	1	9	Pork		
PE	1	1	10	Goat		
PE	3	10	11	Poultry		
PE	1	1	12	Delicatessen		
PE	1	1	13	Other Meat Preps		
PE	1	1	14	Other Meats		
PE	1	1	15	Fresh Fish	6	Fish
PE	1	1	16	Dried Fish		
PE	1	1	17	Fresh Seafood		
PE	1	1	18	Preserv Fish/Seafood		
PE	3	10	19	Fresh Milk	7	Milk, Cheese & Egg
PE	1	1	20	Condensed Milk		
PE	1	1	21	Other Milk		
PE	3	10	22	Cheese		
PE	3	10	23	Eggs		
PE	3	10	24	Butter	8	Oils & Fats
PE	1	1	25	Margarine		
PE	1	1	26	Edible Oils		
PE	1	1	27	Other Fats/Oils		
PE	1	1	28	Fresh Fruit	9	Fruit, Veg & Potato
PE	1	1	29	Dried Fruits/Nuts		
PE	1	1	30	Fruit Juice		
PE	1	1	31	Fresh Vegetables		
PE	1	1	32	Dried Vegetables		
PE	1	1	33	Frozen Vegetables		
PE	1	1	34	Pres Veg Juice/Soup		
PE	1	1	35	Potatoes		
PE	1	1	36	Potato Products		
PE	3	10	37	Raw Sugar	10	Other Foods
PE	1	1	38	Coffee		
PE	1	1	39	Tea		
PE	1	1	40	Cocoa		
PE	1	1	41	Jams, Honey		
PE	1	1	42	Choco & Coca Preps		
PE	1	1	43	Confectionery		
PE	1	1	44	Ice & Ice Cream		
PE	1	1	45	Spices & Sauces		
PE	1	2	46	Mineral Water	12	Non-Alcoholic Bev
PE	1	2	47	Other Soft Drinks		
PE	3	10	48	Spirits & Liquors	13	Alcoholic Bev
PE	1	2	49	Wine		

PE	1	2	50	Beer		
PE	1	2	51	Other Wine, Alcoh		
PE	3	10	52	Cigarettes	14	Tobacco
PE	1	2	53	Other Tobacco		
PE	1	3	54	Men's Clothing	16	Clothing Incl Reps
PE	1	3	55	Ladies' Clothing		
PE	1	3	56	Children's Clothing		
PE	1	3	57	Infant's Clothing		
PE	1	3	58	Materials, Yarns		
PE	3	11	59	Repair of Clothing		
PE	1	3	60	Men's Footwear	17	Footwear Incl Reps
PE	1	3	61	Ladies' Footwear		
PE	1	3	62	Children Footwear		
PE	3	11	63	Repairs to Footwear		
PE	3	11	64	Rents	19	Gross Rent & Water
PE	3	11	65	Imputed Rents		
PE	3	11	66	Repair of House		
PE	3	11	67	Sanitary & Water		
PE	1	4	68	Electricity	20	Fuel and Power
PE	1	4	69	Natural Gas		
PE	1	4	70	Liquid Petroleum		
PE	1	4	71	Liquid Fuels (Light)		
PE	1	4	72	Coal, Coke		
PE	2	5	73	Furniture & Fixt	22	Furnit, Floor & Reps
PE	2	5	74	Carpets		
PE	3	11	75	Repair of Furn/Floor		
PE	2	5	76	Hsehld Textiles	23	Hhold Textiles & Reps
PE	3	11	77	Repairs - Hsehld Text		
PE	2	5	78	Fridge, Freezers	24	Hhold Appliance & Rep
PE	2	5	79	Washing Machines		
PE	2	5	80	Cookers, Ovens		
PE	2	5	81	Heaters, Air-Cond		
PE	2	5	82	Vacuum Cleaners		
PE	2	5	83	Other Hhld Appl		
PE	3	11	84	Repair - Hhld Appl		
PE	2	5	85	Glass/Tableware	25	Other Hhold G & S
PE	2	5	86	Cutlery		
PE	2	5	87	Motorless Utensils		
PE	2	5	88	Motorless Gard Appl		
PE	2	5	89	Electric Bulbs		
PE	3	11	90	Repaire - Ware		
PE	2	5	91	Cleaning Prod		
PE	2	5	92	Other Non-Dur Hhld G		
PE	3	11	93	Dry Clean		
PE	3	11	94	Other Hhld Serv		
PE	3	11	95	Domestic Serv		
PE	999	999	96	Drugs and Medic Prep	126	Medic & Health Care
PE	999	999	97	Other Medic Supplies		
PE	999	999	98	Spectacle Lenses		
PE	999	999	99	Therap. Appl Nec		
PE	999	999	100	Serv - General Pract		

PE	999	999	101	Serv - Specialist		
PE	999	999	102	Serv - Dentist		
PE	999	999	103	Serv - Nurse		
PE	999	999	104	Serv - Other Pract		
PE	999	999	105	Medical Analyses		
PE	999	999	106	Hosp - Medic Staff		
PE	999	999	107	Hosp - Non-Med Staff		
PE	999	999	108	Food and Bev		
PE	999	999	109	Pharmaceut Prod		
PE	999	999	110	Therapeut Equip		
PE	999	999	111	Other Equip		
PE	999	999	112	Water & Energy Prod		
PE	999	999	113	Maint & Other Serv		
PE	999	999	114	Hosp - Cap Consumpt		
PE	2	6	115	Passenger Vehicles	128	Person Transp Equip
PE	2	6	116	Motorcycle & Bikes		
PE	2	6	117	Tires, Tubes	129	Oper of Trans Equip
PE	3	12	118	Repair & Maint Serv		
PE	2	6	119	Motor Fuels, Oils		
PE	3	12	120	Care Hire, Tolls		
PE	3	12	121	Local _ Bus, Train, Tax	130	Purch Transp Serv
PE	3	12	122	Long - Coach & Rail		
PE	2	6	123	Long - Air & Sea		
PE	3	12	124	Other Purch Transp		
PE	3	12	125	Postal	131	Communication
PE	3	12	126	Telephone		
PE	2	7	127	Radio Sets	133	Recrea Equip & Reps
PE	2	7	128	TV, Video		
PE	2	7	129	Tape Recorder		
PE	2	7	130	Cameras		
PE	2	7	131	Other Dur Recrea G		
PE	2	7	132	Records, Tapes		
PE	2	7	133	Sports Goods		
PE	2	7	134	Games, Toys		
PE	2	7	135	Films		
PE	2	7	136	Flowers & Pets		
PE	3	13	137	Reps - Recrea G		
PE	3	13	138	Cinemas	134	Recrea & Cult Serv
PE	3	13	139	Sport/Recrea Activit		
PE	3	13	140	TV Rent/Licence		
PE	3	13	141	Photo Serv		
PE	2	7	142	Books	135	Books, Mags
PE	3	13	143	Newspapers		
PE	3	13	144	Educational Fees	144	Educational Fees
PE	3	11	145	Hairdressers	139	Other G & S
PE	2	8	146	Dur Toilet Artcl		
PE	2	8	147	Non-dur Toilet Artcl		
PE	3	11	148	Jewellery & Reps		
PE	2	8	149	Travel Goods		
PE	2	8	150	Persn Accessories		
PE	2	8	151	Writing Equip/Suppl		

PE	3	11	152	Restaurants	138	Rest, Cafes & Hotel
PE	3	11	153	Pubs, Bars, Cafes		
PE	3	11	154	Staff Canteens		
PE	3	11	155	Hotels & Other		
PE	3	11	156	Finance Serv Nec	139	Other G & S
PE	3	11	157	Other Serv Nec		
PE	999	999	158	Net Purch Abroad	158	Net Purch Abroad
GE	999	999	159	CS: Compens of Employ		
GE	999	999	160	CS: Intermed Consmpt	999	Govt Final Consum
GE	999	999	161	CS: Consumpt - Fix Cap		
GE	999	999	162	Ed: Compens of Empl		
GE	999	999	163	Ed: Intermed Consmpt		
GE	999	999	164	Ed: Consumpt - Fix Cap		
GE	999	999	165	Drugs & Medic Preps		
GE	999	999	166	Other Medic Supply		
GE	999	999	167	Spectacle Lenses		
GE	999	999	168	Therap Appliance NEC		
GE	999	999	169	Serv - Gen Pract		
GE	999	999	170	Serv - Specialist		
GE	999	999	171	Serv - Dentist		
GE	999	999	172	Serv - Nurse		
GE	999	999	173	Serv - Other Pract		
GE	999	999	174	Medical Analyses		
GE	999	999	175	Hosp - Medic Staff		
GE	999	999	176	Hosp - Non Medic Staff		
GE	999	999	177	Food and Bev		
GE	999	999	178	Pharmaceut Prod		
GE	999	999	179	Therap Equip		
GE	999	999	180	Other Equip		
GE	999	999	181	Water & Energy Prod		
GE	999	999	182	Maint & Other Serv		
GE	999	999	183	Consumpt of Fix Cap		
GE	999	999	184	Oth Publ Hlth Serv		
GE	999	999	185	Welfare Services		
GE	999	999	186	Recreat/Cult Serv		
KFME	2	9	187	Struct Metal Prod	149	Non-Electrical Equip
KFME	2	9	188	Prod - Boilermaking		
KFME	2	9	189	Tool/Finish Metal G.		
KFME	2	9	190	Agricult Mach/Tractr		
KFME	2	9	191	Mach Tool - Met Wrk		
KFME	2	9	192	Mine, Metalrgy Equip		
KFME	2	9	193	Textile Machinery		
KFME	2	9	194	Machine - Food/Chemic		
KFME	2	9	195	Machine - Wood/Leath		
KFME	2	9	196	Other Mach & Equip		
KFME	2	9	197	Off & Data Proc Mach		
KFME	2	9	198	Precision Instrument		
KFME	2	9	199	Optical/Photo Equip		
KFME	2	9	200	Electrical Equip	250	Electrical Equip
KFME	2	9	201	Telecomm Equip		
KFME	2	9	202	Electronic Equip		

KFME	2	9	203	Motor Vehicl & Engin	248	Transport Equip
KFME	2	9	204	Boats,Steamers,Tugs		
KFME	2	9	205	Locomotives, Wagons		
KFME	2	9	206	Aircraft, Hovercraft		
KFME	2	9	207	Bicycles, Motorcycles		
KFCON	3	14	208	One - Family Dwell	244	Residential Bldg
KFCON	3	14	209	Multi - Family Dwell		
KFCON	3	14	210	Agricult Bldg	245	Non-Resident Bldg
KFCON	3	14	211	Industrial Bldg		
KFCON	3	14	212	Bldg - Market Serv		
KFCON	3	14	213	Bldg - Non Mark Serv		
KFCON	3	14	214	Roads & Highways	246	Civil Engineering Wrks
KFCON	3	14	215	Other Transp Routes		
KFCON	3	14	216	Other Civil Eng Wrk		
KFOTH	999	999	217	Other Products	900	Gross fixed capital formation
KSC	999	999	218	Change - Stock	218	Change - Stock
NEXP	999	999	219	Net Exports - G & S	219	Net Exports - G & S

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